

## EXECUTIVE SUMMARY

### INTRODUCTION

The U.S. Air Force (USAF), in performing its primary mission of defense of the United States, has frequently engaged in operations that deal with toxic and hazardous materials. Department of Defense policy is to identify and fully evaluate suspected problems associated with past hazardous contamination, and to control hazards to public health and welfare that resulted from these past operations. The Installation Restoration Program (IRP) is the basis for response actions on USAF installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as clarified by Executive Order 12316.

The identification of several hazardous waste sites at Hill Air Force Base (Hill AFB) has resulted in the placement of Hill AFB on the National Priority List (NPL). Under the IRP, contamination resulting from past waste disposal is now being investigated at Hill AFB. Figure ES-1 shows the location of IRP sites on Hill AFB.

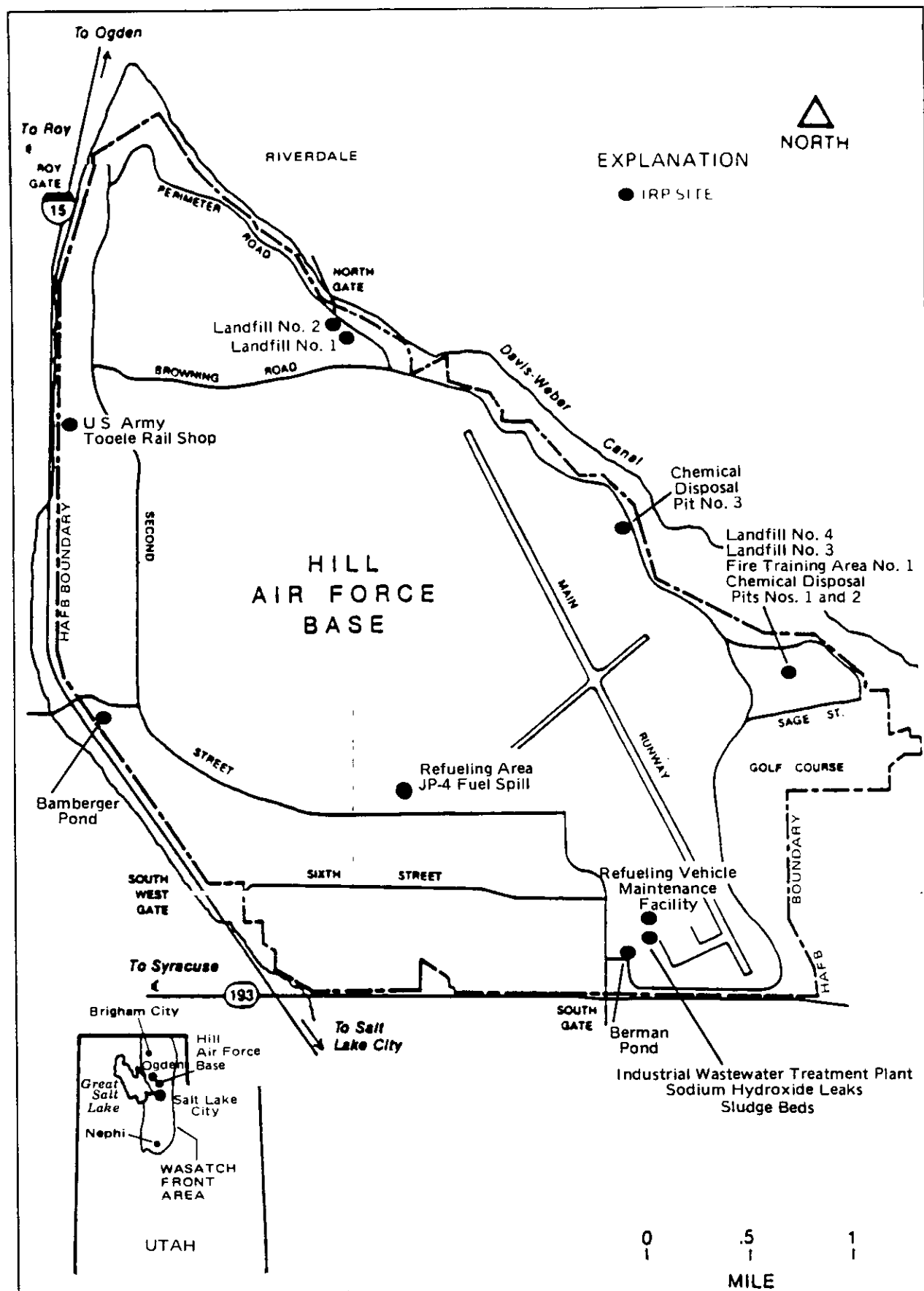


Figure ES-1 General locations of IRP sites on Hill AFB. (Radian Corp., 1988, fig.1.6-1).

## PURPOSE AND SCOPE OF THE INVESTIGATION

IRP studies at Hill AFB include the Phase I Records Search conducted by Engineering Science during 1981 (Engineering-Science, 1982). This records search provided a history of landfill operations and indicated that organic chemicals had not been disposed in landfills 1 and 2.

The Phase II Confirmation/Quantification Stage 2 study of Hill AFB was conducted from November 1985 to November 1987 (Radian Corp., 1988). Three monitoring wells were drilled near landfills 1 and 2 and chemical analyses were performed on water samples from the wells. Large concentrations of trichloroethylene (TCE), 4,185  $\mu\text{g/L}$ , were detected in the well downgradient of landfill 1. In a well downgradient from landfill 2, the concentration of TCE was 6.08  $\mu\text{g/L}$ .

The U.S. Geological Survey began an investigation of contamination of operable unit 4 (landfills 1 and 2) at Hill AFB, Utah, in September 1987. The primary objectives of the investigation were completion of scoping activities and beginning site characterization activities.

Scoping activities completed were: (1) collection of existing data about the site, (2) preliminary identification of site boundaries, (3) identification of potential Applicable or Relevant and Appropriate Requirements (ARAR's), (4) preparation of the quality assurance project plan, work plan, and health and safety plan.

Site characterization activities completed were: (1) definition of boundaries of the landfills, (2) determination of vertical and horizontal hydraulic gradients, (3) determination of physical and hydrologic characteristics of soils and sedimentary units, (4) determination of extent and sources of contaminant plumes, (5) determination of contaminants which have the potential for migrating in sediments or in ground water, (6) identification of unidentified compounds reported in previous reports (Radian Corp., 1988, p. 4-244).

#### ENVIRONMENTAL SETTING

Hill AFB is located in northern Utah about 25 miles north of Salt Lake City and about 5 miles south of Ogden (fig. ES-1). Hill AFB is located on the Weber Delta, a terrace about 300 feet above the valley floor in Weber and Davis Counties. Hill AFB covers about 6,700 acres.

Hill Field was commissioned in 1940, and during World War II aircraft were rehabilitated there. Hill Field was renamed Hill Air Force Base in 1948 after the Army Air Corps became the U.S. Air Force. In 1979, Hill AFB assumed logistical management of the F-16 aircraft.

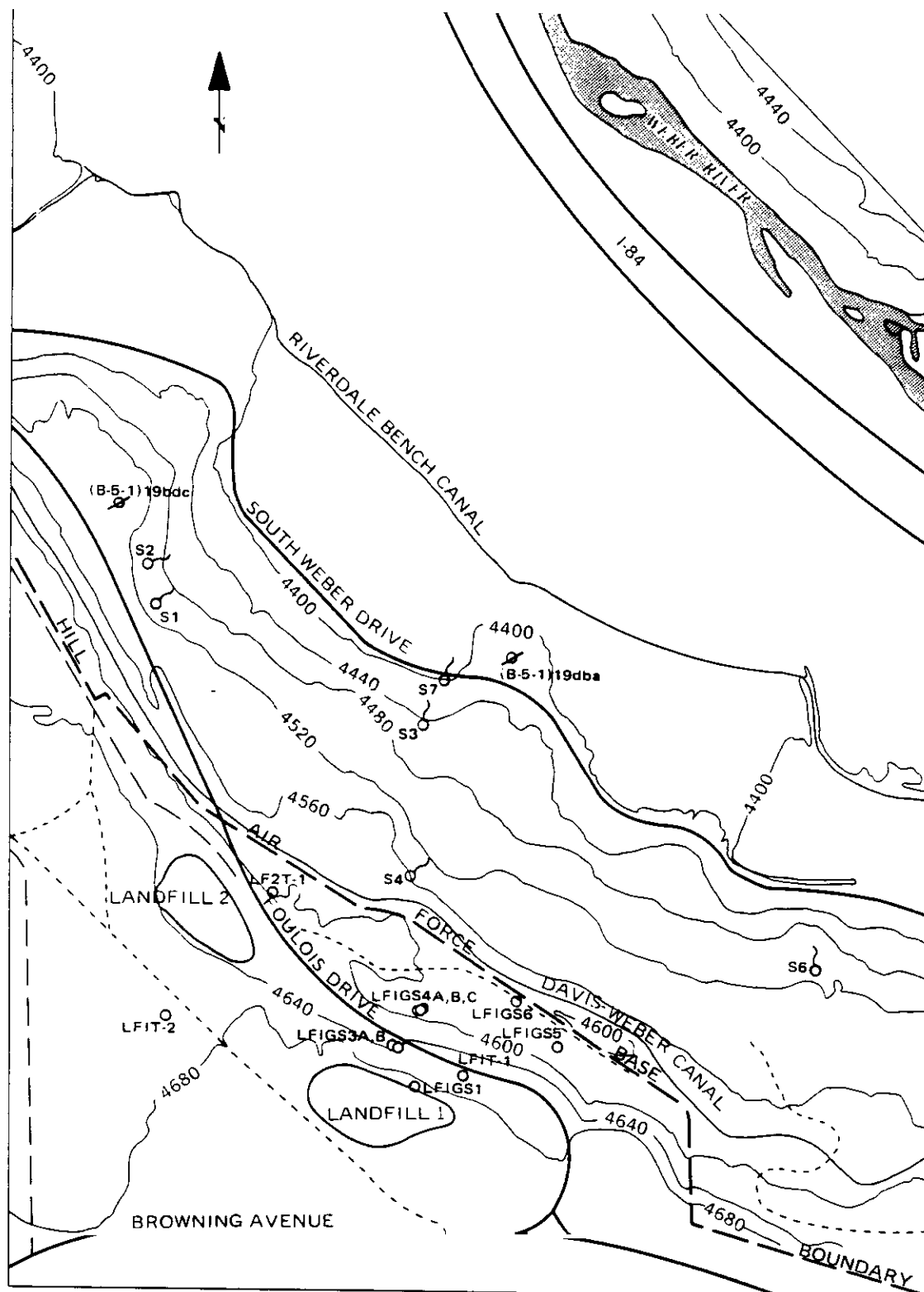
Hill AFB overlies 3 aquifers. Two of the aquifers, the Delta and the Sunset aquifers, are productive sources of good quality water and are used by both Hill AFB and surrounding communities. Water in these aquifers generally is confined and occurs at a depth of more than 200 feet below land surface. Shallow unconfined water occurs locally near Hill AFB above the Delta and Sunset aquifers. It is unknown if this shallow unconfined water is perched on clay layers with unsaturated material below, or whether the entire system is saturated down to the deeper aquifers.

The land use in the area includes urban, suburban, agricultural (both irrigated and dryland farming), and vacant ground. The land west of Hill AFB is entirely urban, whereas the north and southeast sides are mostly rural.

Hill AFB is surrounded by the incorporated towns of South Weber, Washington Terrace, Riverdale, Roy, Sunset, Clearfield, and Layton. The population of these communities in 1980 was 80,521 and in 1985 was 95,719. About 66 percent of the increase, over 15,000 in five years, was from growth of Layton.

#### SITE DESCRIPTION

Contamination detected near landfills 1 and 2 was investigated by the U.S. Geological Survey. Landfills 1 and 2 are located along a steep, terraced, north-facing escarpment that separates the Weber Delta (on which Hill AFB is located) from the Weber River valley (fig. ES-2). The Weber Delta consists of unconsolidated clay, silt, sand, and gravel deposited by streams flowing into former Lake Bonneville.



**EXPLANATION**

LFIGS6 ○ MONITORING WELL  
 (B-5-1)19bdc ⊗ PRIVATE WELL  
 S4 ⊙ SEEP

0 500 1,000 FEET  
 0 100 200 300 METERS  
 CONTOUR INTERVAL 10 FEET  
 DATUM IS SEA LEVEL

**Figure ES-2 Location of wells and seeps where samples for chemical analyses have been collected near landfills 1 and 2, Hill AFB.**

Landfill 1 covers about 5 acres and is located in the northeastern part of Hill AFB. Mr. Joseph Fisher, former foreman of refuse collection, recalled the site was about 25 feet deep. The landfill was operated as a hillside dump with a daily burning operation from 1955 until 1967, when burning at Hill AFB was terminated. Available records indicate little if any chemical wastes were disposed of in the landfill. This landfill may have received waste from the Ogden Arsenal which may have included waste oils and solvents from their vehicle maintenance facilities (Radian Corp., 1988, p. 4-240).

Landfill 2 is located about 900 feet northwest of landfill 1. Landfill 2 was operated between 1963 and 1965; general waste was dumped down the side of the hill and periodically burned. There are no records of chemicals being disposed of at this site. Landfill 2 is a shallow pit at present and ponds water, which probably increases the amount of water moving through the fill, and thus, the amount of leachate leaving the landfill.

#### FIELD PROGRAM

The U.S. Geological Survey conducted four major field activities at Hill AFB as part of the Remedial Investigation of landfills 1 and 2. These activities consisted of the following: (1) geophysical survey, (2) soil-gas surveys, (3) installation of eight monitoring wells, and (4) collection and analysis of soil and ground-water samples (fig. ES-2). The field activities began in February and ended in October 1988.

## SUMMARY OF RESULTS

A potentiometric surface map was prepared from water levels in 11 wells near landfills 1 and 2 (fig. ES-3). The horizontal component of the hydraulic gradient is to the north or northeast (the direction the ground water flows), the same as the topographic gradient. Water levels in well cluster LF1GS3A,B, immediately downgradient of landfill 1, indicated upward movement of water and contamination in the shallowest zone but not in the deeper zone. Water levels in well cluster LF1GS4A,B,C about 250 feet further downgradient, indicated downward movement but most contamination was still confined to the shallower zone.

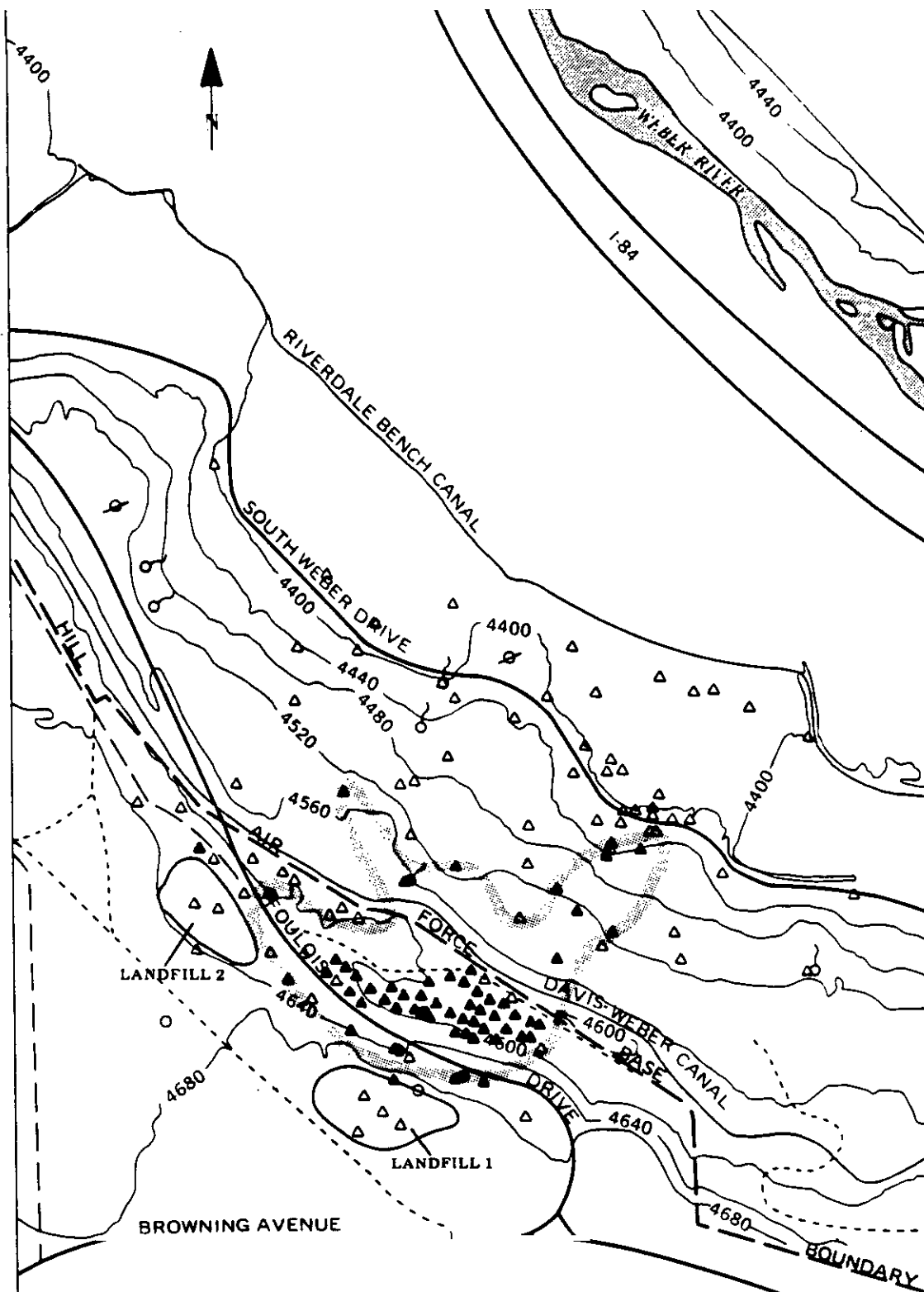
Brown clay with thin silt and sand lenses was the predominant material encountered during drilling. The thickness of the silt and sand lenses generally ranged from 0.25 to 2 inches. The maximum vertical average linear velocity of the fluids was estimated, using vertical gradients and laboratory hydraulic conductivity values, to be about 0.02 foot per year. Inspection of cores during drilling indicated that most of the silt and sand lenses were horizontal. Because vertical hydraulic conductivity values are so small, most flow probably occurs horizontally in the thin lenses of silt and sand.



A surface geophysical survey was conducted using an instrument which measures the ground electrical conductivity. The data indicated that the ground electrical conductivity values were anomalously high in both landfills and in areas downgradient of the landfills. Specific conductance of water in wells downgradient of landfill 1 were greater than background and appear to support the ground electrical conductivity data.

The ground electrical conductivity values and specific conductance of the ground-water samples suggest, but do not confirm, that inorganic leachates are originating in the landfills. Inorganic chemical analyses of water from the existing and proposed wells are needed to determine the chemical composition of the compounds causing the larger specific conductance values in the ground water and to assist with definition of flow paths and to better define or confirm source areas.

Soil-gas surveys were conducted during March-October 1988 to determine organic vapor concentrations on and near landfills 1 and 2 and on private land outside Hill AFB boundary (fig. ES-4). No organic vapor concentrations exceeding background (0.1 ppm) were measured in either of the landfills, and essentially all of the concentrations exceeding background values occurred at a few sites immediately south of Foullois Drive and at a large number of sites in the area north and downgradient of Foullois Drive and on private land outside the Hill AFB boundary.



### EXPLANATION

- |     |        |                                     |
|-----|--------|-------------------------------------|
|     |        | PLUME BOUNDARY                      |
| TCE | NO TCE | SAMPLING SITE FOR CHEMICAL ANALYSIS |
| ●   | ○      |                                     |
| ○   | ○      |                                     |
| ○   | ○      |                                     |
| ●   | ○      | Seep                                |
| ▲   | △      | SOIL-GAS DATA-COLLECTION SITE       |

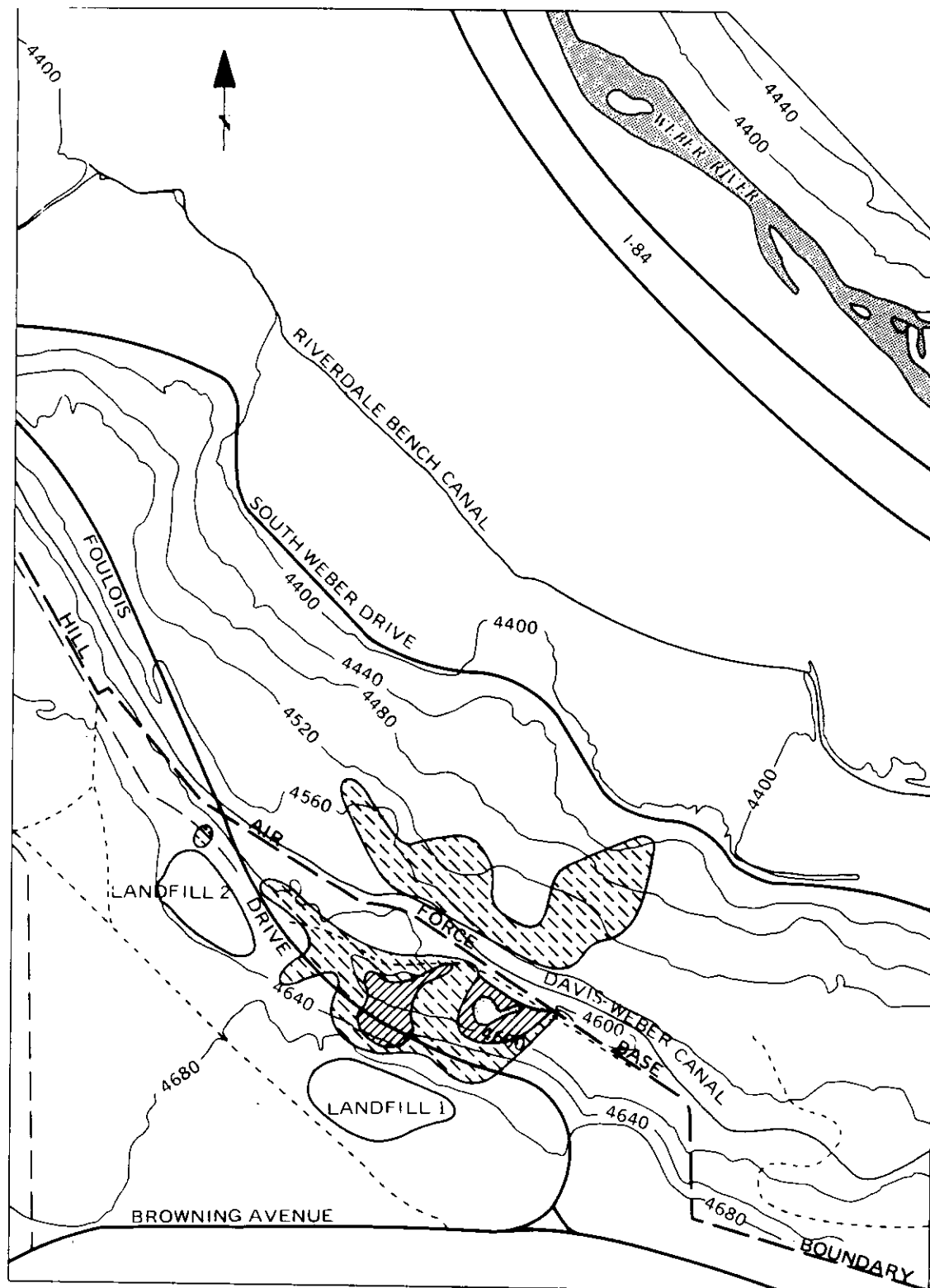
0 500 1,000 FEET  
0 100 200 300 METERS  
CONTOUR INTERVAL 40 FEET  
DATUM IS SEA LEVEL

Figure ES-4 Soil-gas measuring sites during March-October 1988, near landfills 1 and 2, Hill AFB.

Chemical analyses of water samples from the monitoring wells support the soil-gas results. Wells LF1T-1 and LF1GS6 and the clusters of wells at LF1GS3 and LF1GS4 are located in areas where soil-gas concentrations exceeded background concentrations. Except for the deepest wells in the clusters, chemical analyses of water samples from these wells indicated TCE concentrations ranging from 545.9 to 5,044  $\mu\text{g/L}$  (table ES-1). Wells LF1GS1, LF1GS5, and LF2T-1 are located in areas where soil gas was not detected above background. Chemical analyses of water from these wells indicated either no detection of TCE or concentrations ranging from only 6.08 to 35.4  $\mu\text{g/L}$ .

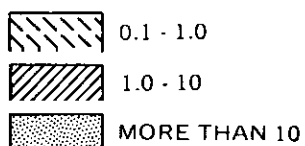
The southwesternmost (upgradient) occurrence of TCE noted during soil-gas surveys or in chemical analyses of water samples is immediately south of Foullois Drive (fig. ES-4). The source of the contaminants observed in this area may be from roadside disposal and/or barrel storage. Contaminants disposed of in this area could have infiltrated into the ground water and may have run off along the south side of Foullois Drive in ditches.

The largest concentration of contaminants identified by soil-gas measurements is within 20 ft of the Hill AFB boundary (fig. ES-5), in an area that may have been a dumping site. The TCE concentration in water from well LF1GS6, which is in this area, was 1,422  $\mu\text{g/L}$  when sampled in June 1988.



### EXPLANATION

ORGANIC VAPOR CONCENTRATION, AS  
TRICHLOROETHYLENE, IN PARTS PER  
MILLION



0 500 1,000 FEET  
0 100 200 300 METERS  
CONTOUR INTERVAL 40 FEET  
DATUM IS SEA LEVEL

Figure ES-5 Organic vapor concentrations in soil-gas from March-October, 1988, near landfills 1 and 2, Hill AFB.

Table ES-1 Concentrations of selected contaminants in water  
from wells and seeps near landfills 1 and 2, Hill AFB

Well or seep no.	Date Sampled	TCE <sup>1</sup> (µg/L)	DCE <sup>1</sup> (µg/L)	Benzene (µg/L)	Acetone (µg/L)	MEX <sup>1</sup> (µg/L)	Sulfate (mg/L)
Within Hill AFB boundary							
LF1T-1	06-17-86	4,185	ND <sup>1</sup>	NA <sup>1</sup>	NA	NA	290
	08-19-86	832	ND	NA	NA	NA	310
	03-30-88	1,500	ND	ND	110	120	NA
LF1T-2	06-17-86	ND	ND	NA	NA	NA	26
	08-19-86	ND	ND	NA	NA	NA	31
LF2T-1	06-17-86	6.08	ND	NA	NA	NA	34
	08-19-86	11.5	ND	NA	NA	NA	22
	03-30-88	10	6.4	ND	ND	ND	NA
LF1GS1	06-24-88	ND	ND	ND	NA	NA	NA
LF1GS3A	06-20-88	ND	ND	ND	NA	NA	NA
LF1GS3B	06-23-88	5,044	124	ND	NA	NA	NA
LF1GS4A	06-24-88	19	ND	ND	NA	NA	NA
LF1GS4B	06-07-88	637.5	8.1	ND	NA	NA	NA
LF1GS4C	06-07-88	545.9	2.9	ND	NA	NA	NA
LF1GS5	06-06-88	35.4	ND	ND	NA	NA	NA
LF1GS6	06-22-88	1,422	130	61	NA	NA	NA
Outside Hill AFB boundary							
S1	09-02-88	ND	ND	ND	ND	ND	79
	09-19-88	ND	ND	NA	NA	NA	NA
S2	09-02-88	ND	ND	ND	ND	ND	68
	09-19-88	ND	ND	NA	NA	NA	NA
S3	09-02-88	ND	ND	ND	ND	ND	NA
	09-19-88	ND	ND	NA	NA	NA	NA

Table ES-1 Concentrations of selected contaminants in water from wells and seeps near landfills 1 and 2, Hill AFB Continued

Well or seep no.	Date Sampled	TCE <sup>1</sup> (µg/L)	DCE <sup>1</sup> (µg/L)	Benzene (µg/L)	Acetone (µg/L)	MEK <sup>1</sup> (µg/L)	Sulfate (mg/L)
S4	07-27-88	190.2	1.6	NA	NA	NA	90
	09-12-88	86	ND	ND	NA	NA	NA
S6	10-19-88	ND	ND	ND	NA	NA	NA
S7	10-19-88	ND	ND	ND	NA	NA	NA
(B-5-1)19bdc	09-19-88	ND	ND	NA	NA	NA	NA
(B-5-1)19dba	09-19-88	ND	ND	NA	NA	NA	NA
ARAR		5.0		5.0			1,000

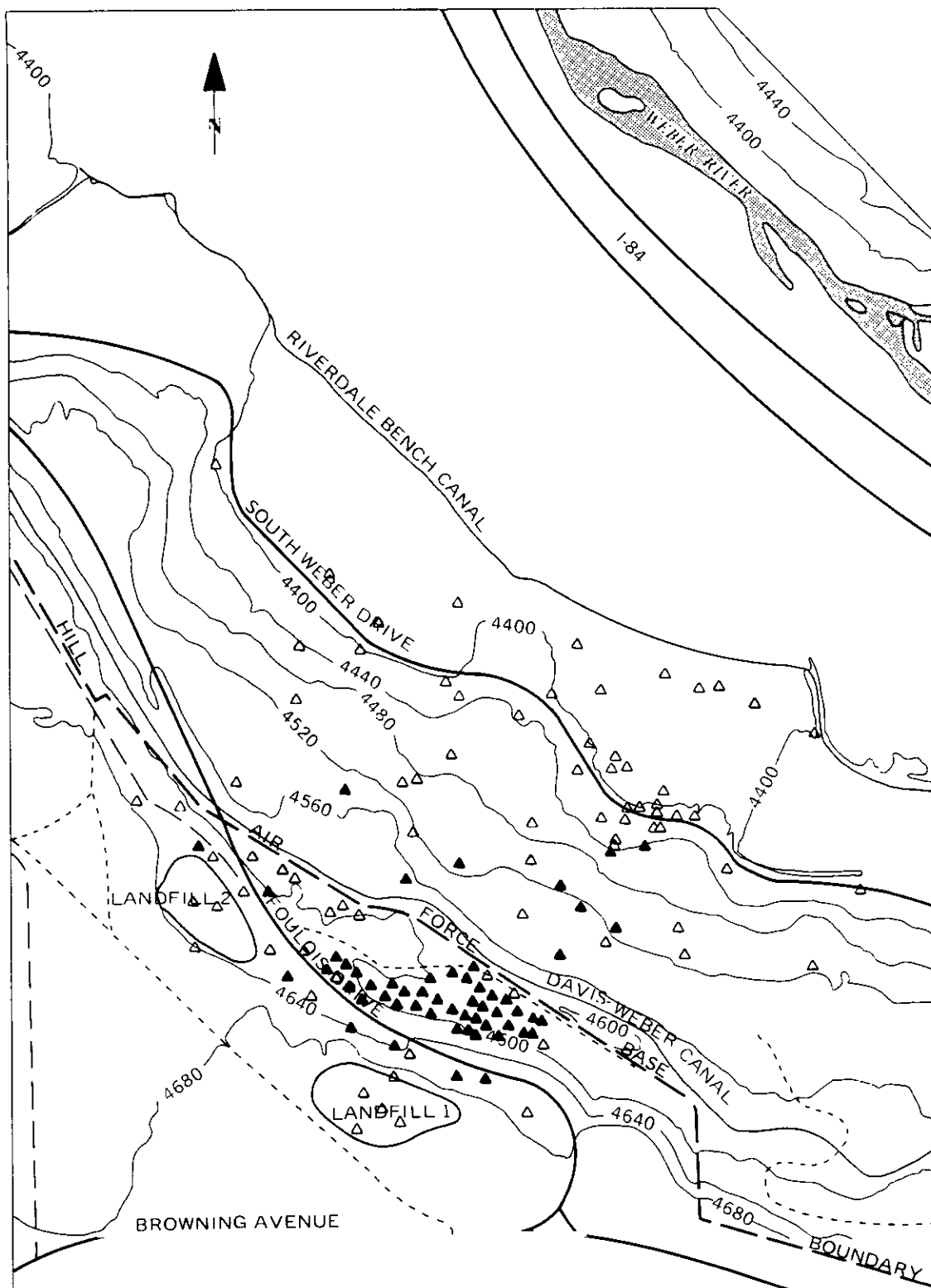
<sup>1</sup>Abbreviations used: TCE, Trichloroethylene; DCE, trans-1,2-Dichloroethene; MEK, Methyl Ethyl Ketone; ND, Not detected; NA, not analyzed; ARAR, Applicable or Relevant and Appropriate Requirements.

Well LF1GS1, which is in the general ground-water flow path between landfill 1 and the contaminated wells downgradient, did not contain TCE or other organic contaminants. The absence of TCE in a water sample from well LF1GS1 and in soil-gas vapors in the landfill essentially eliminates landfill 1 as a possible source area of TCE.

The areal extent of contamination near landfills 1 and 2 was estimated from the chemical analyses and soil-gas surveys. Within the boundary of Hill AFB, the contaminated area was estimated to be about 15 acres and outside the boundary it was estimated to be about 9 acres (fig. ES-6).

Two private wells and six seeps (fig. ES-2) outside the Hill AFB boundary were sampled, and seep S4, which is on the steep embankment immediately below the Davis-Weber Canal, is the only water source where TCE was detected. Concentrations of TCE in samples collected from seep S4 in July and September 1988, were 190 and 86  $\mu\text{g/L}$ , respectively. Although seep S4 is near the Hill AFB boundary and was the only water source found to contain TCE outside the Hill AFB boundary, the soil-gas survey suggests that the contaminants have migrated about 920 feet downgradient from the boundary (fig. ES-6).

The water-use inventory made on private lands outside the Hill AFB boundary during August-October 1988, determined that shallow ground water was not being used as a source of drinking water. However, data are not available to determine if the contaminated shallow ground water may eventually migrate into deeper principal aquifers used as sources of drinking water for nearby communities.



### EXPLANATION

- SOIL-GAS MEASURING SITE
- △ TRICHLOROETHYLENE (TCE) LESS THAN 0.1 PARTS PER MILLION
  - ▲ TRICHLOROETHYLENE (TCE) GREATER THAN 0.1 PARTS PER MILLION

0 500 1,000 FEET  
0 100 200 300 METERS  
CONTOUR INTERVAL 10 FEET  
DATUM IS SEA LEVEL

Figure ES-6 Plume boundary as estimated from soil-gas measurements and from chemical analyses for trichloroethylene (TCE) in ground water near landfills 1 and 2, Hill AFB.

## RECOMMENDATIONS

### Site Categorization

Sites can be assigned to one of three categories for recommendation purposes. These categories are:

1. Sites where no further action is required.
2. Sites requiring additional work to assess the extent of contamination.
3. Sites that require and are ready for remedial action.

Landfills 1 and 2 belong to category 2; additional work is needed.

### Recommendations for Additional Work

Before remedial action can be taken at landfills 1 and 2, more information is needed to assess the extent of contamination and to complete site characterization. Additional information and further evaluation are needed on the following:

1. Source and type of contaminants.
2. Areal and vertical extent of contamination.
3. Rate of migration of the contaminants.
4. The human health and environmental risk associated with each contaminant.
5. The remedial alternatives.

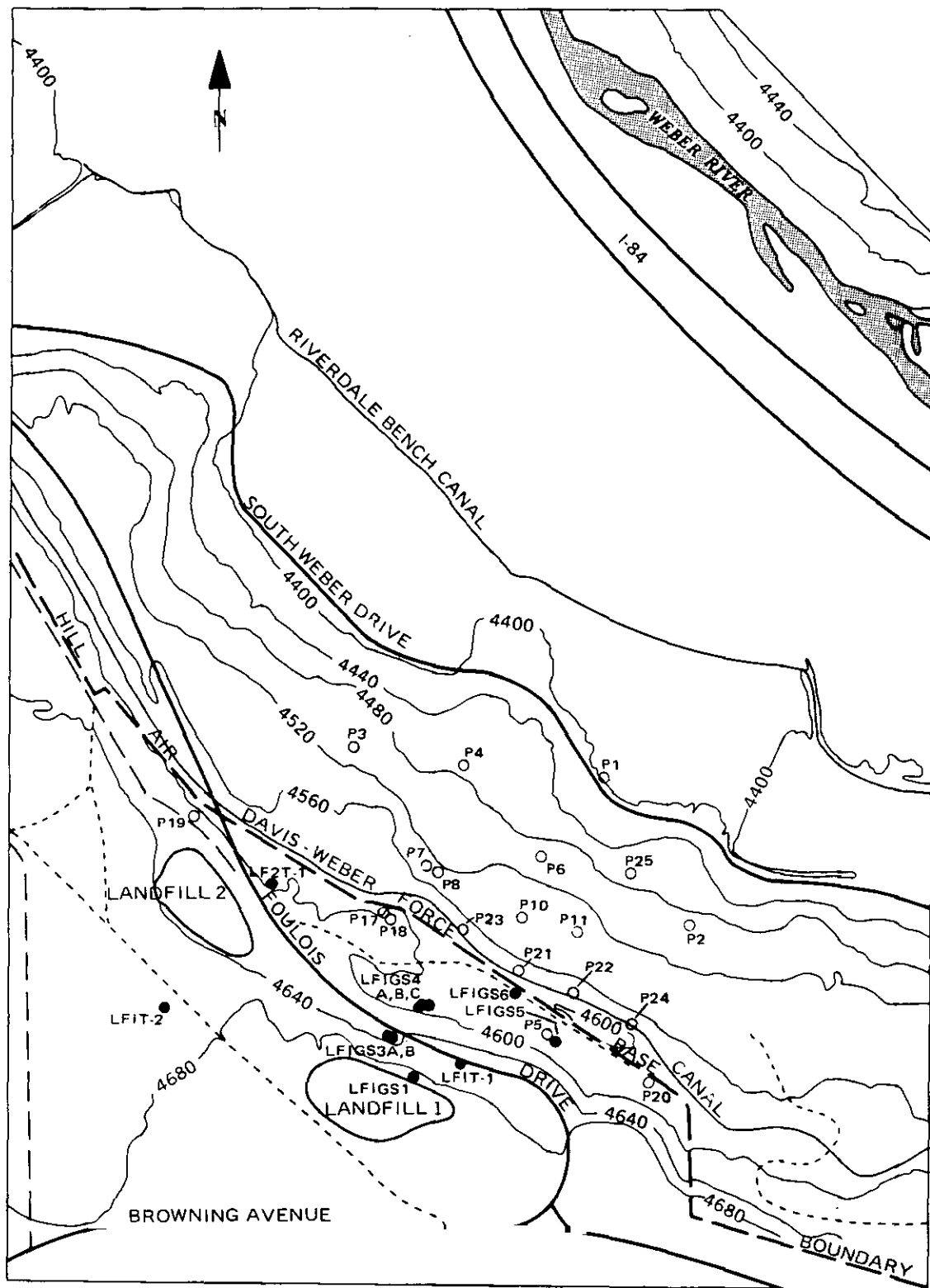
## Source and Type of Contaminants

Both the soil-gas survey and chemical analyses of samples from monitoring wells indicate that the largest concentrations of contaminants associated with landfills 1 and 2 are along Foullois Drive and extend to the installation boundary. Additional monitoring wells are needed to define contamination in the suspected source areas inside the Hill AFB boundary (item 1, table ES-2 and fig. ES-7).

Because of the nature of chemical disposal at the site, analyses need to be done for all categories of chemicals that may have been used or disposed of on Hill AFB. It is recommended that a more comprehensive analytical schedule be run on water and sediment from sites near wells LF1T-1, LF1GS3B, LF1GS4B,C, and LF1GS6, where the contamination was greatest. Chemical analyses for volatile organic compounds and any other contaminants detected in the expanded analytical schedule need to be made at several sampling sites and at several times during the year to determine seasonal variation in contaminant concentrations. Table ES-3 shows the types and number of chemical analyses recommended for the existing and proposed monitoring wells.

Table ES-2 Recommended data collection to facilitate site characterization of landfills 1 and 2, Hill AFB.

Recommended Site Work	Purpose
1. Construct 2-inch monitor wells P5, P17, and P18.	Determine extent of contamination near suspected source area.
2. Construct 2-inch monitor well P19.	Determine if contaminants are associated with large ground electrical conductivity values downgradient from landfill 2.
3. Construct 2-inch monitor wells P7, P8, P10, P11, P21, P22, P23, and P25 inside estimated plume boundary.	Confirm contamination, define concentrations of contaminants and potentiometric surface.
4. Construct 2-inch monitor wells P1, P2, P3, P4, P6, P20, and P24 outside estimated plume boundary.	Confirm boundary of contamination and define potentiometric surface.
5. Collect samples for field gas-chromatograph analysis of selected volatile organic compounds.	Define vertical extent of contamination.
6. Collect and analyze water samples.	Characterize the inorganic and organic water chemistry (table ES-3).
7. Collect core samples from all proposed wells.	Determine geotechnical properties and define lithology.
8. Conduct slug tests in all wells.	Determine hydraulic conductivity values.
9. Construct 4-inch monitor well for an aquifer test at site P5.	Define hydrologic properties of aquifer.
10. Continuously monitor water levels in the canal and wells LF2T-1, LF1GS6, P3, and P17.	Determine the influence of canal water on the potentiometric surface.
11. Define elevation of canal bottom.	Define relationship of canal bottom to ground-water elevation.
12. Monitor discharge of seep S4.	Relate influence of canal water on discharge of seep.



### EXPLANATION

- LFIT-2 EXISTING MONITORING WELL
- P19 PROPOSED MONITORING WELL

0 500 1,000 FEET  
 0 100 200 300 METERS  
 CONTOUR INTERVAL 40 FEET  
 DATUM IS SEA LEVEL

Figure ES-7 Proposed locations for new monitoring wells near landfills 1 and 2, Hill AFB.

Table ES-3 Schedule for analysis of sediment and water  
for existing and proposed wells and seeps

Parameter	Number of samples
Soil/Sediment	
Extraction procedure toxicity	8
Volatile organic compounds	42
Base/neutrals and acid extract	10
Organochlorine pesticides	2
Semi-volatile organics	2
Chlorinated herbicides	2
Soil-moisture content	20
Atterberg limits	20
Grain size	20
Organic content	20
Hydraulic conductivity	20
Water	
Ion balance <sup>1</sup>	100
Gross alpha and beta activity	4
Metals/inorganics	8
pH (field)	152
Conductance (field)	152
Temperature (field)	152
Volatile organic compounds	100
Chlorinated herbicides	4
Semi-volatile organics	10

<sup>1</sup>Analysis for major cations and anions should include nitrite and nitrate.

Analyses for major and trace inorganic constituents are needed to characterize the quality of water moving through the landfills. Analyses for the major constituents should include nitrate because site P19 is downgradient from a munitions disposal area. Water in the areas where ground electrical conductivity values were large needs to be sampled to determine if toxic trace constituents are present (items 2 and 6, table ES-2 and fig. ES-7).

#### Areal and Vertical Extent of Contamination

Seep S4 contained TCE in concentrations of 86 and 190.2  $\mu\text{g/L}$ , confirming that contaminants have migrated beyond the Hill AFB boundary (table ES-1 and fig. ES-2). The soil-gas surveys suggest that contaminants have migrated about 920 feet beyond the Hill AFB boundary onto private land (fig. ES-6).

Additional wells are needed to confirm contamination and identify types and concentrations of contaminants within and outside the plume boundary estimated from the results of the soil-gas survey and existing chemical analyses (items 3, 4, and 6, table ES-2 and fig. ES-7). In all proposed wells, core samples need to be collected during drilling for field analysis of selected volatile organic compounds to define the vertical extent of contamination (item 5, table ES-2 and fig. ES-7). After the wells have been developed, water samples are needed to characterize the inorganic and organic chemistry (item 6, table ES-2 and fig. ES-7).

## Rate of Migration of the Contaminants

Core samples should be collected (item 7, table ES-2) during drilling of all proposed wells to determine geotechnical properties and define the lithology. The geotechnical information is needed to compute volumes of contaminants and provide supplemental hydrologic data needed for computing rates of contaminant migration.

Aquifer tests are needed so that rates of ground-water and contaminant movement can be computed. Slug tests should be performed to determine hydraulic conductivity values at each well (item 8, table ES-2). Also, an aquifer test needs to be conducted using a pumping well (proposed well P5, fig. ES-7) so that additional hydrologic properties of the aquifer can be determined (item 9, table ES-2). The test would provide data on maximum pumping rates that can be sustained and would facilitate design of remedial alternatives that involve actions such as pumping and treating contaminated water.

An investigation should be conducted on the relationship and influence of the Davis-Weber Canal on the shallow ground water (items 10-12, table ES-2). Data collection should include continuous monitoring of the potentiometric surface of the ground water near the canal, the water level in the canal, and the discharge of seep S4 near the canal. All data should be collected concurrently, beginning about one month prior to the diversion of water into the canal (usually April) and continuing for about one month after diversions to the canal cease (usually October).

Water levels need to be measured at monthly intervals in all of the monitoring wells. The potentiometric surface maps determined from the monitoring well data will define ground-water flow direction in the study area. Also, seasonal hydrographs can be used to identify sources of recharge to the aquifer.

#### Human Health and Environmental Risks Associated with Each Contaminant

Two of the primary unknowns that need to be evaluated to characterize health and environmental risks are knowledge of the exposed population and exposure-point concentrations. After exposure data are available the toxicity can be assessed.

Once the above data are collected, the risk assessment can be completed. A public health specialist or toxicologist can assess the health risks of the contaminants, individually and collectively. Wildlife biologists and botanists can assess environmental risks.

#### Remedial Alternatives

The site is not ready for remedial action; additional work is needed to assess the extent of the contamination.